

**Before the  
FEDERAL COMMUNICATIONS COMMISSION  
Washington, D.C. 20554**

In the Matter of	)	
	)	
Reassessment of Federal Communications	)	ET Docket No. 13-84
Commission Radiofrequency Exposure	)	
Limits and Policies	)	
	)	
Proposed Changes in the Commission’s Rules	)	ET Docket No. 03-137
Regarding Human Exposure to Radiofrequency	)	
Electromagnetic Fields	)	

**COMMENTS OF PONG RESEARCH CORPORATION**

Pong Research Corporation (“Pong”) submits these comments in response to the Federal Communications Commission’s (“FCC”) First Report And Order, Further Notice of Proposed Rule Making, and Notice Of Inquiry (“NOI”) in the above-captioned dockets. Most of Pong’s comments relate to the NOI portions of these proceedings.

**TABLE OF CONTENTS**

<b>Heading</b>	<b>Page</b>
I. INTRODUCTION AND BACKGROUND	4
II. CURRENT FCC GUIDELINES UNDERESTIMATE CHILDREN’S EXPOSURE TO RF ENERGY. THE GUIDELINES	6

	MUST BE MODIFIED SUFFICIENTLY TO PROTECT CHILDREN.	
	A. Use of Wireless Devices by Children has Skyrocketed in Recent Years, Outpacing Antiquated 1997 FCC Regulations.	7
	B. Children Absorb Substantially More RF Energy than Adults.	8
	C. The FCC’s Guidelines Must be Modified Sufficiently to Protect Children.	10
III.	CURRENT FCC TESTING PROTOCOLS UNDERESTIMATE CONSUMERS’ EXPOSURE TO RF ENERGY GENERALLY, DUE TO PROXIMITY GUIDELINES THAT UNDERESTIMATE NORMAL USE. THE GUIDELINES MUST BE MODIFIED SO THAT TESTING OF DEVICES SIMULATES PROXIMITIES THAT ACCURATELY REFLECT NORMAL USE.	11
	A. Users Today Do Not Typically Keep Their Devices at a Distance of 15mm to 25 mm in Body Worn Configuration (the Distance Assumed Under the FCC’s Antiquated 1997 Guidelines)—But Rather Directly Against the Body.	12
	B. Users Generally Absorb RF Energy Well in Excess of the FCC’s Current Guidelines.	13
	C. The FCC’s Testing Guidelines Must Be Changed, to Reflect Zero Spacing In Body Worn Configurations.	15
IV.	DEVICE CERTIFICATION TESTING SHOULD ACCOUNT FOR ACCESSORIES THAT ARE COMMON TODAY, AND THAT SUBSTANTIALLY IMPACT RF ENERGY ABSORPTION—SPECIFICALLY CASES—AS THE CURRENT ANTIQUATED STANDARDS FROM 1997 ALREADY ACCOUNT FOR LESS PREVALENT ACCESSORIES SUCH AS BELT CLIPS AND HOLSTERS.	16
	A. RF Testing Should Account for the Presence of Cases, as it Already Requires for Less Prevalent Accessories Like Belt Clips and Holsters.	17
	B. OET Bulletin 65 Provided That Device Testing Should be “Based On Normal Operating Positions Or Conditions,” and that Testing	18

Should Account for Accessories.	
C. Bulletin 65—Acknowledged Testing Anomalies.	22
D. Though Bulletin 65 from 1997 Discusses Accessories Such as Belt Clips and Holsters, there is no Express Reference to Wireless Device Cases, as Cases and Smart Phones Did Not Exist in 1997.	23
E. Case Market Statistics Today, and Consumer Adoption of Wireless Devices.	24
F. Effects of Cases on Portable Devices: Cases Can Completely Change (and May Increase) Radiation Absorption.	25
G. Test Data Demonstrate that Cases Can Eviscerate the Entire Equipment Authorization Process.	26
H. Both Metallic and Non-Metallic Cases Can Affect SAR. The Commission Should Eliminate the Antiquated Presumption that Non-Metallic Accessories Cannot Impact SAR, and Revise Its Testing Guidelines and Consumer Notifications Accordingly.	27
V. CONSUMER INFORMATION SHOULD BE MORE ACCESSIBLE AND INFORMATIVE, INCLUDING AT POINT OF SALE.	32
VI. THE FCC SHOULD ENCOURAGE CONSUMER AWARENESS OF RF ENERGY ISSUES AND PRECAUTIONARY MEASURES, AND SHOULD NOT RELAX EXISTING SAFETY STANDARDS	34
VII. CONCLUSION	36

## I. INTRODUCTION AND BACKGROUND

An estimated 326.4 million wireless subscriber connections exist in the United States, which equates to a penetration rate of 102.2%.<sup>1</sup> Most consumers today rely heavily on their portable devices, and use and carry them against their heads and bodies for increasingly longer periods—and, indeed, even sleep with them.<sup>2</sup>

The wireless world has changed dramatically since the Commission established its current radio-frequency (RF) energy testing guidelines for portable devices, which have remained in place since 1997.<sup>3</sup> Then, fewer than 20% of Americans had a mobile phone.<sup>4</sup> Most users were adults who owned cell phones for business purposes. But today many factors—including the extent of usage, the time each day that users keep devices directly against their bodies, and changing user demographics (including skyrocketing use among children)—have rendered the FCC’s testing regime inconsistent with consumers’ “real world” behaviors.

In the United States, smartphone ownership has grown to: 79% among adults age 18-24, 81% for ages 25-34, 69% for ages 35-44, 55% for ages 45-54, 39% for ages 55-64, and 18% for ages 65 and over. Adoption rates have increased by up to 18% within

---

<sup>1</sup> See <http://ctia.org/media/index.cfm/AID/10323>.

<sup>2</sup> See <http://www.digitalbuzzblog.com/infographic-how-adults-are-using-mobile-phones> and <http://www.time.com/time/health/article/0,8599,1658166,00.html>.

<sup>3</sup> See Office of Engineering and Technology Bulletin 65, as amended (“Bulletin 65”), *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, edition 97-01, August 1997.

[http://transition.fcc.gov/Bureaus/Engineering\\_Technology/Documents/bulletins/oet65/oet65.pdf](http://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf). The Commission later issued supplements to Bulletin 65 that purposed, *inter alia*, “to provide parties filing applications for equipment authorization with guidance on complying with the latest requirements using up-to-date test procedures . . . [but was] not intended, however, to establish mandatory procedures [given that] other methods and procedures may be acceptable if based on sound engineering practice.” *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, Supplement C (Edition 01-01) to Bulletin 65 (“Supplement C”), June 2001, preamble. [http://transition.fcc.gov/Bureaus/Engineering\\_Technology/Documents/bulletins/oet65/oet65c.pdf](http://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65c.pdf).

<sup>4</sup> <http://ctia.org/media/index.cfm/AID/10323>.

these age groups just between 2012 and 2013.<sup>5</sup> The percentage of adults who own tablet computers—that likewise connect to cellular or Wi-Fi networks—nearly doubled from 18% to 34%.<sup>6</sup>

A Government Accountability Office (“GAO”) Report released August 7, 2012 (the “GAO Report”)<sup>7</sup> called for the FCC to update its portable device radiation exposure and testing guidelines. According to the GAO Report, current FCC standards—in place since 1997 (some 4 years before the first smartphones became commercially available)—“*may not reflect the latest research,*”<sup>8</sup> “*may not identify maximum exposure [to radiation] in all possible usage conditions,*”<sup>9</sup> and do not test for use of phones against the body, which “*could result in RF energy exposure higher than the FCC limit.*”<sup>10</sup> Apropos the GAO’s concerns, **Appendix A** to this filing lists various scientific studies and summarizes recent research on the impact of RF energy on humans.

We are pleased that the FCC has commenced its NOI on wireless device safety. This filing recommends updates to the FCC’s device testing guidelines. These changes would enhance consumer safety and improve awareness of precautionary measures to reduce RF energy exposure. Given the ubiquity of portable devices, we urge the FCC to modernize its guidelines, so that consumers generally—and children, in particular—

---

<sup>5</sup> Smith, A., Pew Internet & American Life Project, Pew Research Center, Smartphone Ownership Update--2013, June 5, 2013, at page 3, [http://www.pewinternet.org/~media/Files/Reports/2013/PIP\\_Smartphone\\_adoption\\_2013.pdf](http://www.pewinternet.org/~media/Files/Reports/2013/PIP_Smartphone_adoption_2013.pdf).

<sup>6</sup> Zickuhr, K., Pew Internet & American Life Project, Pew Research Center, Tablet Ownership 2013, June 10, 2013, <http://www.pewinternet.org/Reports/2013/Tablet-Ownership-2013.aspx>.

<sup>7</sup> GAO Report, *Exposure and Testing Requirements for Mobile Phones Should Be Reassessed*, GAO-12-771, July 2012, <http://www.gao.gov/assets/600/592901.pdf>.

<sup>8</sup> GAO Report, *Highlights* page.

<sup>9</sup> *Id.*

<sup>10</sup> *Id.* The GAO Report states: “Some consumers may use mobile phones against the body, which FCC does not currently test, and could result in [radio frequency (“RF”) energy exposure higher than the FCC limit.” Further, the GAO Report observes: “Some consumer groups noted that they would like FCC to mention [the International Agency for Research on Cancer’s] recent classification of RF energy exposure as ‘possibly carcinogenic’ on FCC’s website.” *Id.*, at page 26.

might become more informed about, and so reduce their unnecessary exposure to, RF radiation from wireless devices.

## **II. CURRENT FCC GUIDELINES UNDERESTIMATE CHILDREN'S EXPOSURE TO RF ENERGY. THE GUIDELINES MUST BE MODIFIED SUFFICIENTLY TO PROTECT CHILDREN.**

The NOI seeks comment on the impact of cell phones on children. Section 6 states:

*“[T]he Commission invites health and safety agencies and the public to comment on the propriety of our general present limits and whether additional precautions may be appropriate in some cases, for example with respect to children.”*<sup>11</sup>

Section 219 *“specifically seek[s] comment as to whether our current limits are appropriate as they relate to device use by children.”*<sup>12</sup> Section 245 similarly states:

*“The SAM [Specific Anthropomorphic Mannequin] does not model children, tissue layers, or a hand holding the device but SAM was designed to be conservative relative to these factors . . . . Since it is not possible to measure the [Specific Absorption Rate or “SAR”]<sup>13</sup> in a 1-gram cube of tissue within the head of a real human being, and given that each human being is different, we request comment on the pros and cons of measurement versus computation, as well as standardization of human models in general, and the significance of these issues in comparison with procedures that have already been standardized.”*<sup>14</sup>

---

<sup>11</sup> NOI, Section 6, emphasis added.

<sup>12</sup> NOI, Section 219, emphasis added.

<sup>13</sup> See *In re Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation*, Release No. 96-326, 11 F.C.C.R. 15123, 15124 (1996). The Commission adopted the current RF radiation exposure standards that establish a maximum SAR of 1.6 watts per kilogram (1.6 W/kg) for spatial peak SAR as averaged over any 1 gram of tissue. See 47 C.F.R. §2.1093(d)(2). All wireless devices distributed or sold in the United States must comply with this limit.

<sup>14</sup> NOI, Section 245, emphasis added.

**A. *Use of Wireless Devices by Children has Skyrocketed in Recent Years, Outpacing Antiquated 1997 FCC Regulations.***

Today, nearly 8 in 10 children in the United States aged 10 to 14 have a cell phone, and 1 in 3 teens sends more than 3,000 texts per month.<sup>15</sup> Seventy-seven percent of teens aged 12 to 17, and 57% of teens aged 12 to 13, have a cell phone.<sup>16</sup> These figures represent a doubling of cell phone ownership by teenagers just since 2004.<sup>17</sup> Although teens may talk less on their phones than adults, they generally keep their devices on their persons (in so-called “body worn configurations”) for far longer exposure periods.

In a recent survey, 4 out of 5 all teens that owned a cell phone reported sleeping with their phones on or by their beds.<sup>18</sup> Teens who text were 42% more likely to keep their devices close at night, in case they got a text.<sup>19</sup> Seventy-eight percent of 12 to 13 year-olds who had mobile phones reported sleeping right next to them.<sup>20</sup> At the same time, pediatricians cite growing evidence that cell phones can disrupt children’s sleep patterns.<sup>21</sup>

---

<sup>15</sup> *Cell Phone–Technology, Exposures, Health Effects*, Environment and Human Health, Inc., February 2012, [http://www.ehhi.org/reports/cellphones/cell\\_phone\\_report\\_EHHI\\_Feb2012.pdf](http://www.ehhi.org/reports/cellphones/cell_phone_report_EHHI_Feb2012.pdf), at page 19.

<sup>16</sup> See <http://pewinternet.org/Reports/2012/Teens-and-smartphones/Summary-of-findings.aspx>, and <http://www.pewinternet.org/Reports/2013/Teens-and-Tech/Summary-of-Findings.aspx>.

<sup>17</sup> [http://www.americanpressinstitute.org/docs/foundation/research/fitting\\_into\\_their\\_lives.pdf](http://www.americanpressinstitute.org/docs/foundation/research/fitting_into_their_lives.pdf).

<sup>18</sup> <http://children.webmd.com/features/children-and-cell-phones>. Pew reports that 84% of teens sleep with their cell phones on or close to their beds. See [http://www.pewinternet.org/~media/Files/Reports/2010/PIP\\_Adults\\_Cellphones\\_Report\\_2010.pdf](http://www.pewinternet.org/~media/Files/Reports/2010/PIP_Adults_Cellphones_Report_2010.pdf), at p. 22.

<sup>19</sup> *Id.*

<sup>20</sup> See <http://pewinternet.org/Reports/2010/Teens-and-Mobile-Phones/Chapter-3/Sleeping-with-the-phone-on-or-near-the-bed.aspx>

<sup>21</sup> *Id.*; See also Regel, S.J. et al., *Pulsed Radio-Frequency Electromagnetic Fields: Dose Dependent Effects on Sleep, the Sleep EEG and Cognitive Performance*, J Sleep Res 2007, 16:253-258; Huber, R., et al., *Electromagnetic Fields, Such as those from Mobile Phones, Alter Regional Blood Flow and Sleep and Waking EEG*, Journal of Sleep Research, 2002; 11:289-295; Arnetz, B.B. et al., *The Effects of 884 MHz GSM Wireless Communication Signals on Self-Reported Symptom and Sleep (EEG)—An Experimental Provocation Study*, PERS Online 3(7): 1148-1150 2007.

**B. Children Absorb Substantially More RF Energy Than Adults.**

The FCC's RF radiation exposure testing process, in place since 1997 (when wireless penetration in the United States was less than 20%),<sup>22</sup> uses a plastic model of the human head and body called the "SAM" that, in terms of body mass, represents the top 10% of American military recruits in 1989.<sup>23</sup> The Commission's antiquated SAR standards, then, fail both to reflect the general population and, in particular, to account accurately for cell phone use by children and adolescents.

Leading researcher Om P. Gandhi has noted:

*"[T]he existing cell phone certification process uses a plastic model of the head called the Specific Anthropomorphic Mannequin (SAM), representing the top 10% of U.S. military recruits in 1989 and greatly underestimating the [SAR] for typical mobile phone users, especially children . . . ."*<sup>24</sup>

Children absorb materially more electro-magnetic radiation ("EMR") than adults.

Research proves, for example, that a 10-year old child absorbs EMR at rates 153% that of an adult.<sup>25</sup> Gandhi noted the following:

*"[RF] exposure to a head smaller than SAM will absorb a relatively higher SAR. Also, SAM uses a fluid having the average electrical properties of the head that cannot indicate differential absorption of specific brain tissue, nor absorption in children or smaller adults. The SAR for a 10-year old is up to 153% higher than*

---

<sup>22</sup> See <http://ctia.org/media/index.cfm/AID/10323>.

<sup>23</sup> Gandhi, O.P. et al., *Exposure Limits: The Underestimation of Absorbed Cell Phone Radiation, Especially in Children*, Electromagnetic Biology and Medicine, Early Online, 1-18 (2011).

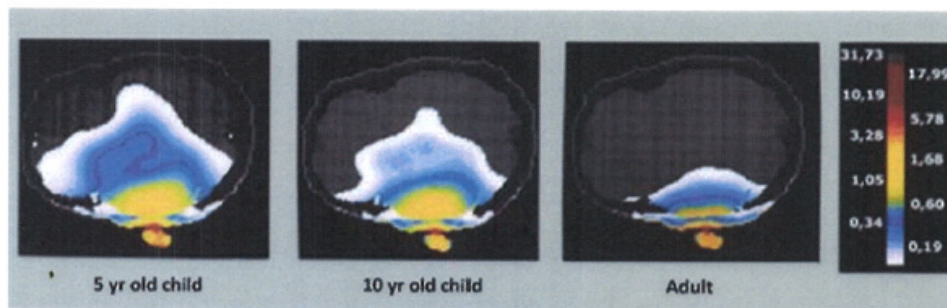
<sup>24</sup> *Id.*

<sup>25</sup> *Id.* "The SAR for a 10-year old is up to 153% higher than the SAR for the SAM model. When electrical properties are considered, a child's head's absorption can be over two times greater, and absorption of the skull's bone marrow can be ten times greater than adults."



*the SAR for the SAM model. When electrical properties are considered, a child's head's absorption can be over two times greater, and absorption of the skull's bone marrow can be ten times greater than adults.*<sup>26</sup>

Gandhi proved this fact graphically<sup>27</sup> in **Figure 1**.



**Figure 1.** This figure shows SAR distributions for an adult male typical of SAM, a 10-year old child, and a 5-year old child—on the scale shown.

Frequency = 900 MHz

A February 2012 publication by Environment and Human Health, Inc., *Cell Phone – Technology, Exposures, Health Effects*, likewise noted:

*“The model used to estimate the SAR for a cell phone user’s head was derived from the size and dimensions of the head of a large adult male. A comparison of anatomically based models of the human head shows that this SAR may underestimate the absorption rate in children by a factor of two or more. Studies show deeper penetration of absorbed energy in a child’s head, the result of the thinness of the outer ear and skull of young children.*

*“Experiments have shown that smaller head models produce statistically higher SAR values than larger models. The National Academy of Sciences (NAS) notes that better characterization of SARs for children of various age groups is*

<sup>26</sup> *Id.*, at page 11.

<sup>27</sup> *Id.*

*necessary and that current models are not adequate for children.*”<sup>28</sup>

In 2011, the International Agency for Research on Cancer concluded that:

*“When used by children, the average RF energy deposition is two times higher in the brain and up to ten times higher in the bone marrow of the skull, compared with mobile phone use by adults.”*<sup>29</sup>

A number of phone models are specifically marketed to children.

**C. The FCC’s Guidelines Must Be Modified Sufficiently to Protect Children.**

In order sufficiently to protect children, the Commission should develop a more appropriate testing methodology that would—among other things—more accurately measure their “real SAR.” This approach might include, for example, testing models that more accurately simulate the physical characteristics of children, who have thinner skulls and softer tissue. A more comprehensive approach is the so-called FDTD (Finite Difference Time Domain). It uses MRI-scans of a set of real human beings to determine the amount of radiation absorbed in every tissue when exposed to a given phone. The “Virtual Family” approach includes a 5-year old girl, a 6-year old boy, an 8-year old girl, an 11-year old girl, a 14-year old boy, a 26-year old female, a 35-year old male, an obese male adult and 3 pregnant women at 3<sup>rd</sup>, 7<sup>th</sup>, and 9<sup>th</sup> months of gestation. It allows detail not just on what is estimated to be happening in the brain, but in any body part, including the eyes and the testes, tissues known to be especially sensitive to electromagnetic radiation.

---

<sup>28</sup> *Cell Phone – Technology, Exposures, Health Effects*, published by Environment and Human Health, Inc., February 2012, at page 47, [http://www.ehhi.org/reports/cellphones/cell\\_phone\\_report\\_EHHI\\_Feb2012.pdf](http://www.ehhi.org/reports/cellphones/cell_phone_report_EHHI_Feb2012.pdf).

<sup>29</sup> See <http://www.wirelesswatchblog.org/wp-content/uploads/2011/06/Lancet-June-2011-11.pdf> and <http://monographs.iarc.fr/ENG/Monographs/vol102/mono102-F07.pdf>.

**III. CURRENT FCC TESTING PROTOCOLS UNDERESTIMATE CONSUMERS' EXPOSURE TO RF ENERGY GENERALLY, DUE TO PROXIMITY GUIDELINES THAT UNDERESTIMATE NORMAL USE. THE GUIDELINES MUST BE MODIFIED SO THAT TESTING OF DEVICES SIMULATES PROXIMITIES THAT ACCURATELY REFLECT NORMAL USE.**

The NOI asks whether its existing proximity guidelines for testing, which since 1997 have required testing at 15mm to 25 mm for body worn configuration, are appropriate.

Section 7 inquires:

*“Specifically, we seek comment on the feasibility of evaluating portable RF sources without a separation distance when worn on the body to ensure compliance with our limits under present-day usage conditions.”*<sup>30</sup>

The FCC similarly asks in Section 252:

*“In sum, there could be certain circumstances where test configurations may not reflect actual use, and newer technological solutions may exist to allow for devices to be evaluated as close as is feasible to a simulated human under a body-worn configuration. Accordingly, we invite comment as to what steps, if any, the Commission should take relative to our policies for testing of devices on the basis of an expectation of some separation from the body, including whether it is appropriate to consider “zero” spacing, or actual contact with the body when testing.”*<sup>31</sup>

Section 251 also admits:

*“[S]ome devices may not be compliant with our exposure limits without the use of some spacer to maintain a separation distance when body-worn . . . . [W]e seek*

---

<sup>30</sup> NOI, Section 7.

<sup>31</sup> NOI, Section 252.

*comment on the implementation of evaluation procedures without a spacer for the body-worn testing configuration . . . .*”<sup>32</sup>

Our responses and data on these proximity issues appear below.

**A. *Users Today Do Not Typically Keep Their Devices at a Distance Of 15mm to 25 mm in Body Worn Configuration (the Distance Assumed Under the FCC’s Antiquated 1997 Guidelines)—But Rather Directly Against the Body.***

Current FCC testing guidelines, established in 1997, advise device manufacturers to test devices at a distance of up to 25 mm from the body.<sup>33</sup> As the GAO noted, however, consumers ordinarily use devices at far lesser proximities (even at “zero” distance) and, so, the FCC’s methods likely underestimate consumers’ real radiation absorption rates.

As discussed in Pong’s prior FCC filings,<sup>34</sup> most consumers today rely heavily on their portable devices, and use and carry them against their heads and bodies for increasingly longer periods—such that “body worn configuration” has become not the exception but the norm. Indeed, the market is replete with “wearable” devices that operate on wireless networks and at “zero” or near-zero proximity to users, many of which (ironically) tout health and wellness benefits but ignore the potentially adverse health impacts of prolonged RF exposure in the first instance.

Pong elucidated in its filing dated June 29, 2012<sup>35</sup> that testing guidelines in Bulletin 65—that account for accessories not provided by the portable device manufacturer itself, by prescribed testing with a separation distance of 1.5 cm to 2.5 cm

---

<sup>32</sup> NOI, Section 251.

<sup>33</sup> Supplement C, at page 41.

<sup>34</sup> See, e.g., filing of Pong dated May 31, 2012 in WT Docket 11-186, <http://apps.fcc.gov/ecfs/document/view?id=7021921006>.

<sup>35</sup> Filing of Pong dated June 29, 2012 in WT Docket 11-186 and ET Docket 03-137, <http://apps.fcc.gov/ecfs/document/view?id=7021981415>. See especially footnote 10.

for body worn operation and in certain fixed positions for head proximity—may not adequately protect consumers. Among other reasons, consumers do not typically keep their devices between 1.5 cm and 2.5 cm from their bodies or in fixed positions relative to their heads, but rather *against* them. As such, testing a device 15 mm or more away from the person (for body worn configuration) underestimates “real SAR.”

The GAO Report similarly noted that current testing guidelines exclude testing against the body and may, therefore, underestimate true radiation absorption. GAO stated:

*“By not formally reassessing its current limit, FCC cannot ensure it is using a limit that reflects the latest research on RF energy exposure. FCC has also not reassessed its testing requirements to ensure that they identify the maximum RF energy exposure a user could experience. **Some consumers may use mobile phones against the body, which FCC does not currently test, and could result in RF energy exposure higher than the FCC limit.**”<sup>36</sup>*

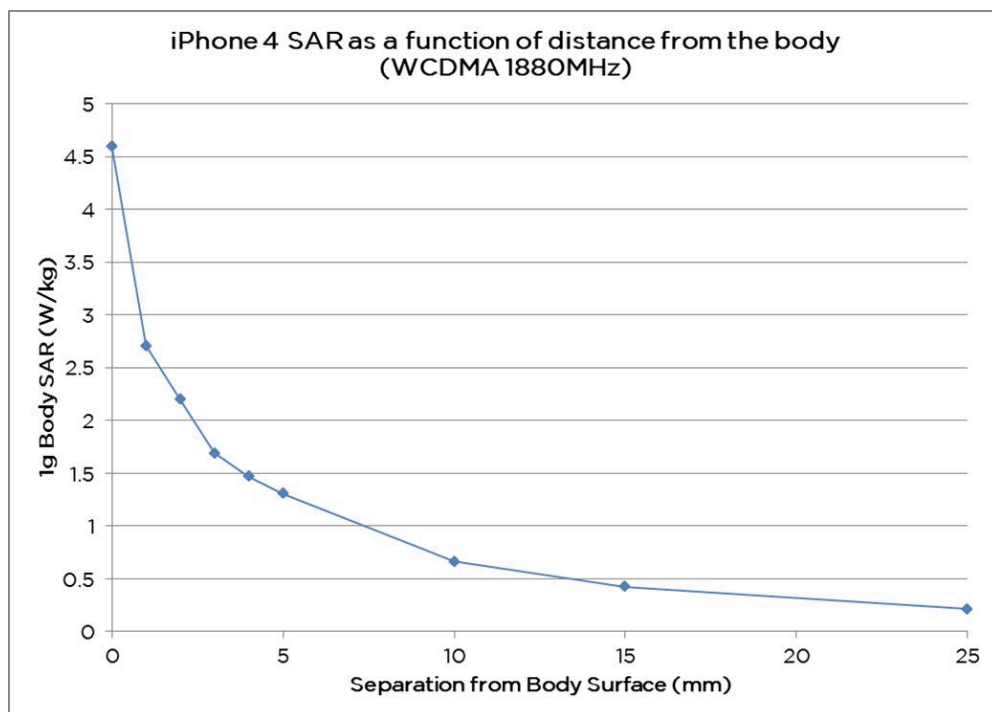
**B. Users Generally Absorb RF Energy Well In Excess Of The FCC’s Current Guidelines.**

In the interest of a fact-based process, Pong tested a bare iPhone 4 (i.e., without a case) in controlled laboratory conditions that simulate EMR exposure *against* the body. (See **Figure 2.**) Testing evidenced a **SAR measurement of 4.6 W/kg, well in excess of the FCC’s safety standard of 1.6 W/kg.** In fact, at 3 mm from the body, the device still exceeded the Commission’s SAR limit.

---

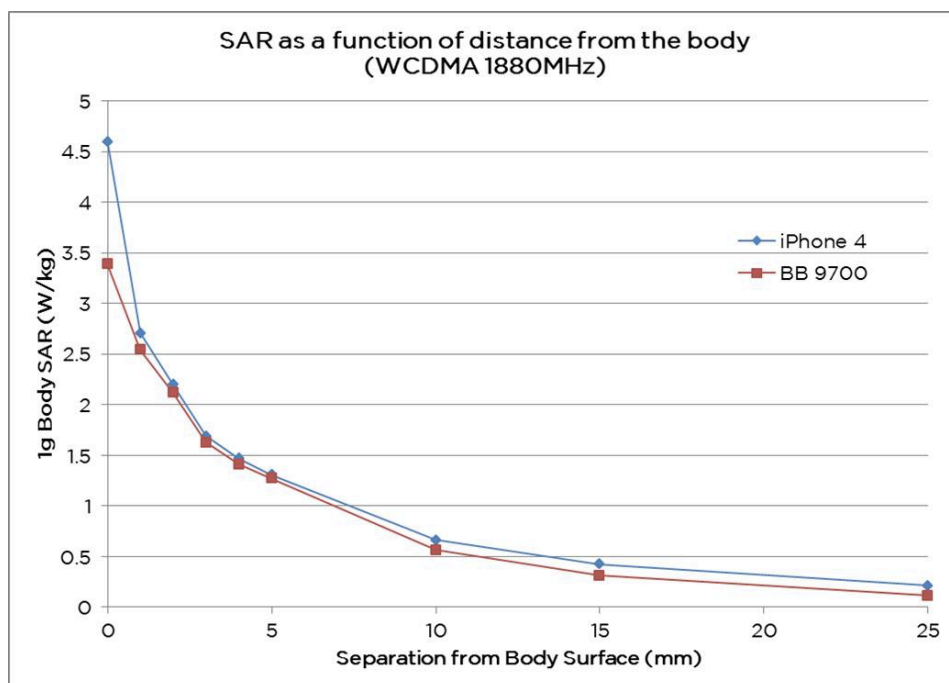
<sup>36</sup> GAO Report, *Highlights* section, emphasis added.

**Figure 2. SAR Results for iPhone 4 at Distances 0—25 mm at WCDMA 1880 MHz**



Results were to the same effect for a BlackBerry 9700—shown below in comparison to the iPhone 4. (See **Figure 3.**)

**Figure 3. SAR Results for BB 9700 at Distances 0—25 mm at WCDMA 1880 MHz**



Indeed a leading device manufacturer concedes in its 28-page Product Information Guide that, when consumers carry the phone in their pockets (which, of course, is what most consumers do), it may expose users to radiation levels higher than the FCC safety limit. An Apple iPhone manual states:

*“iPhone’s SAR measurement may exceed the FCC exposure guidelines for body-worn operation if positioned less than 15 mm (5/8 inch) from the body (e.g., when carrying iPhone in your pocket).”*<sup>37</sup>

Consumers who use certain devices<sup>38</sup> directly against their bodies, then, might continuously experience EMR exposure at levels well in excess of the Commission’s SAR safety limit of 1.6 W/kg. We hope that other commenters in this proceeding will similarly conduct testing to shed as much light as possible on the “real SAR” resulting from the use of portable devices.

***C. The FCC’s Testing Guidelines Must Be Changed, To Reflect Zero Spacing In Body Worn Configurations.***

We believe that testing methodologies should ultimately examine the biological effects of radiation (SAR limits measure only the thermal or heating properties of devices), and encourage the Commission to inform consumers how to exercise precautions to achieve the lowest possible radiation exposure in every instance—whatever the regulatory standard.

We recommend that the FCC modify its testing standards to reflect more accurately how consumers actually use devices—that is, directly against the head or body—which

---

<sup>37</sup> See [http://manuals.info.apple.com/en\\_US/iPhone\\_3G\\_Important\\_Product\\_Information\\_Guide.pdf](http://manuals.info.apple.com/en_US/iPhone_3G_Important_Product_Information_Guide.pdf), at p. 7. This warning appeared in the online version of the guide for the 3GS model (downloaded on June 3, 2013), but did not appear in the online versions of the Guides for the iPhone 4, 4S, or 5 models.

<sup>38</sup> Pong tested only selected devices at the frequencies indicated.

would result in a more accurate measure of consumers' real radiation exposures.

We respectfully submit that, in order properly to protect consumers, the Commission should update its testing guidelines to reflect the use of devices directly against the body rather than at between 15 mm and 25 mm away.<sup>39</sup> Most consumers hold their devices against their bodies and heads. A space of at least 15 mm or more dramatically reduces SAR, but that is not how consumers typically—or, in the Commission's words, as a matter of "*normal operating positions or conditions*"<sup>40</sup>—use devices. Modern habits tend towards much closer proximities, as well as longer exposures.<sup>41</sup>

**IV. DEVICE CERTIFICATION TESTING SHOULD ACCOUNT FOR ACCESSORIES THAT ARE COMMON TODAY, AND THAT SUBSTANTIALLY IMPACT RF ENERGY ABSORPTION—SPECIFICALLY CASES—AS THE CURRENT ANTIQUATED STANDARDS FROM 1997 ALREADY ACCOUNT FOR LESS PREVALENT ACCESSORIES SUCH AS BELT CLIPS AND HOLSTERS.**

Section 252 of the NOI states:

*"[W]e seek comment on whether both requiring that advisory information be more prominent and detailed and supplying accessories to the consumer could be an effective means to ensure adequate awareness and capability to ensure adherence to*

---

<sup>39</sup> Cf. Filing of Pong Research Corporation dated June 29, 2012 in WT Docket 11-186 and ET Docket 03-137, <http://apps.fcc.gov/ecfs/document/view?id=7021981415> (addressing distance standards).

<sup>40</sup> Bulletin 65, at page 42.

<sup>41</sup> It should also be note that operating instructions from leading device manufacturers warn users to not use cell phones close to the body. One leading manufacturer even states that *SAR may exceed allowable limits* when cell phones are held close to the body—precisely how most consumers use cell phones. The following text appears in the user "operating instructions" that the Commission approves for devices of two leading device manufacturers, in connection with the Commission's equipment authorization process: "*iPhone's SAR measurement may exceed the FCC exposure guidelines for bodily worn operation if positioned less than 15 mm (5/8 inch) from the body . . . . When using iPhone near your body for voice calls or for wireless data transmission over a cellular network, keep iPhone at least 15 mm away from the body . . . .*" Apple iPhone User Manual.

*"Keep the [BlackBerry] device at least 0.98 inches (25mm) from your body when the [device] is turned on and connected to a wireless network. When using any data feature of the Blackberry device . . . keep the device at least 0.98 inches from your body."* BlackBerry User Manual.



*the SAR standards under all potential usage conditions.*”<sup>42</sup>

In response, we believe that supplying accessories to the consumer, such as a SAR-reducing case (that does not compromise device signal strength), accompanied with adequate information and disclosures to the consumer, would indeed be an effective means to ensure adequate awareness and capability to ensure adherence to the SAR standards under all potential usage conditions. Analysis and data are provided below.

***A. RF Testing should Account for the Presence of a Case, as it Already Requires for Less Prevalent Accessories like Belt Clips and Holsters.***

Testing should accommodate the pervasive use of cell phone cases by consumers. Cases—like other accessories attached to a portable device—may dramatically alter its radiation profile.<sup>43</sup> Some cases may materially increase radiation absorption, while others may lower it. Testing of devices without a case may eviscerate the purpose of the testing process, which is to accurately measure radiation exposure under normal operating conditions. Current testing standards already account for accessories such as belt clips and holsters, which were pervasive in 1997, but not for cases, which did not exist then. Today, most consumers—85% by some estimates—use cases, while belt clips and holsters are much less common.

The FCC’s Bulletin 65, which dates to 1997, provides that “*portable devices should be tested or evaluated based on normal operating positions or conditions.*”<sup>44</sup>

Bulletin 65 also provided for testing “*with the belt-clips and holsters attached to the*

---

<sup>42</sup> NOI, Section 252.

<sup>43</sup> See <http://apps.fcc.gov/ecfs/document/view?id=7021921006>.

<sup>44</sup> *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, edition 97-01, August 1997, at page 42 (emphasis added), [http://transition.fcc.gov/Bureaus/Engineering\\_Technology/Documents/bulletins/oet65/oet65.pdf](http://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf).

device . . . .’<sup>45</sup>

As part of the Commission’s regulatory regime, the performance of devices is ensured through (among other things) an “equipment authorization process” overseen by the FCC’s Office of Engineering and Technology (“OET”)—the requirements of which appear in 47 C.F.R. Part 15.<sup>46</sup> Broadly speaking, these requirements encompass two components: (1) network service quality (in terms of a device’s performance on the wireless network) and (2) consumer health and safety in terms of a device’s SAR rating. Concerning the second of these factors, Bulletin 65 prescribes recommended practices for determining SAR in the human body due to wireless devices. All devices must pass the testing that Bulletin 65 outlines, before they can be sold to consumers.

***B. OET Bulletin 65 Provided That Device Testing Should be “Based On Normal Operating Positions Or Conditions,” and that Testing Should Account for Accessories.***

Bulletin 65 intended to effect a testing regime that (insofar as possible) replicated consumers’ actual experiences and behaviors vis-à-vis wireless devices, and so expressly states:

*For purposes of evaluating compliance with localized SAR guidelines, portable devices should be tested or evaluated **based on normal operating positions or conditions.***<sup>47</sup>

The Commission went to great lengths to see that testing simulates “normal operating positions or conditions.” For example, Bulletin 65 specifies the positioning of a test

---

<sup>45</sup> *Id.*

<sup>46</sup> Cf. <http://transition.fcc.gov/oet/ea/eameasurements.html> (summarizing various measurement procedures that may be used when testing equipment to determine its compliance with Commission rules).

<sup>47</sup> Bulletin 65, at page 42, emphasis added. “Portable devices”—as opposed to “mobile devices” generally—mean “transmitters whose radiating structures are designed to be used **within 20 centimeters of the body of the user.**” *Id.*, at page 15, emphasis added.

apparatus in relation to a phantom human head and jaw, inasmuch as “*small changes in the positioning of a test device may sometimes lead to unexpected changes in energy absorption in the tissue medium.*”<sup>48</sup> Bulletin 65 also provides for the use of “*a non-metallic holder to position [the device] precisely against the head or body phantom*”<sup>49</sup> despite the fact that “*when handsets are evaluated without a hand model, more energy is absorbed in the head phantom.*”<sup>50</sup> Bulletin 65 further considers temperature<sup>51</sup>; the presence of external DC power adapters<sup>52</sup>; and devices designed for body-worn configurations such as shoulder, waist, or chest-worn transmitters<sup>53</sup>, in simulating “normal” use.

Indeed in Bulletin 65, the Commission recognized that, to simulate *normal operating positions or conditions*, **testing should likewise account for the presence of device accessories**. Supplement C thus states:

*“Body-worn operating configurations should be tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in normal use configurations. Devices with a headset output should be tested with a headset connected to the device.”*<sup>54</sup>

The proliferation of cases (and indeed smart phones) however, largely post-dates the 1997 release of Bulletin 65 and its latest 2001 supplements.<sup>55</sup> The Commission

---

<sup>48</sup> Supplement C, at page 10.

<sup>49</sup> *Id.*

<sup>50</sup> *Id.*

<sup>51</sup> *Id.*, at page 45.

<sup>52</sup> *Id.*, at page 46.

<sup>53</sup> *Id.*

<sup>54</sup> *Id.*, at 41, emphasis added.

<sup>55</sup> For context’s sake, Palm Inc. introduced the Kyocera 6035—the first “smartphone” deployed in widespread consumer use within the United States—in 2001; Research in Motion Limited released its first BlackBerry devices in 2002; and Apple Inc. unveiled the iPhone in 2007.

nonetheless recognized that, *under normal operating positions or conditions*, testing should account for the presence of device accessories. While form-fitting cases as we know them did not exist in 2001—due, among other reasons, to the size and bulk of portable devices at the time, as compared to today’s increasingly small and thin smartphones—accessories like holsters and belt clips had become prevalent.

The Commission further expressly acknowledged that the presence of accessories (like holsters and belt clips) will “*affect the SAR produced by the transmitting device.*”<sup>56</sup> In order to protect consumers further, therefore, Bulletin 65 also stipulated cautionary statements in user manuals: specifically to the effect that ***certain accessories may cause the portable device to exceed the Commission’s RF compliance requirements.*** Bulletin 65 provided that “[i]n order for users to be aware of the body-worn operating requirements for meeting RF exposure compliance, operating instructions and caution statements should be included in the manual. The information should allow users to make informed decisions on the type of body-worn accessories and operating configurations that are appropriate for the device.”<sup>57</sup> Bulletin 65 further provided specific examples of such statements, including a warning that use of certain accessories “***may not ensure compliance with FCC RF exposure guidelines.***”<sup>58</sup>

Furthermore, with great foresight, the Commission in Bulletin 65 anticipated that ***consumers might procure accessories like belt clips and holsters not only from original equipment manufacturers (“OEMs”) but also in the aftermarket.*** (From the

---

<sup>56</sup> Supplement C, at page 41. Supplement C states: “*Both the physical spacing to the body of the user as dictated by the accessory and the materials used in an accessory affect the SAR produced by the transmitting device.*”

<sup>57</sup> *Id.*, at page 41.

<sup>58</sup> *Id.*, emphasis added.

consumer's perspective, the source of these products makes little difference.) Although no meaningful aftermarket for accessories such as cases existed in 2001, **the Commission indicated that caution statements should be provided, even when non-OEM accessories are used with the device.**<sup>59</sup> Among its prescribed caution statements, the Commission recommended the following:

For body worn operation, this phone has been tested and meets the FCC RF exposure guidelines when used with the (manufacturer name) accessories supplied or designated for this product. *Use of **other accessories** may not ensure compliance with FCC RF exposure guidelines.*<sup>60</sup>

And, again:

For body worn operation, this phone has been tested and meets FCC RF exposure guidelines when used with an accessory that **contains no metal** and that positions the handset a minimum of (specified distance) from the body. *Use of **other accessories** may not ensure compliance with FCC RF exposure guidelines.*<sup>61</sup>

The Commission so confirmed that testing should account for the presence of accessories, whether or not those accessories are provided by the manufacturer of the device.<sup>62</sup>

It is important in this context to reiterate that, today, OEM and wireless carrier

---

<sup>59</sup> Supplement C, at page 41.

<sup>60</sup> *Id.*, emphasis added.

<sup>61</sup> *Id.*, emphasis added.

<sup>62</sup> *Id.* “Body-worn accessories may not always be supplied or available as options for some devices that are intended to be authorized for body-worn use. A separation distance of 1.5 cm between the back of the device and a flat phantom is recommended for testing body-worn SAR compliance under such circumstances. Other separation distances may be used, but they should not exceed 2.5 cm. In these cases, the device may use body-worn accessories that provide a separation distance greater than that tested for the device provided however that the accessory contains no metallic components.”

business practices and resultant consumer behavior have largely outstripped the Commission’s regulatory framework. When the Commission promulgated Bulletin 65, OEMs typically included any accessories (like belt-clips and holsters) in a single package at point of sale. Consumers, therefore, could expect that OEMs had accounted for *and tested* such accessories in the equipment authorization process. Today however, wireless carriers and other retailers sell accessories—*that are not tested in the equipment authorization process or otherwise*—in the aftermarket and separate from wireless devices themselves, although many accessories bear carriers’ and OEMs’ private labels. These retailers effectively “bundle” accessories with wireless devices via marketing practices.

**C. *Bulletin 65—Acknowledged Testing Anomalies.***

Notwithstanding the Commission’s intent to produce “real world” test results, Bulletin 65 itself either tacitly or expressly acknowledges many testing anomalies within its regime. Bulletin 65 identifies 23 different reasons why SAR results may vary among testing facilities: (1) axial isotropy error; (2) hemispherical isotropy error; (3) spatial resolution tolerance; (4) boundary-effects error; (5) linearity error; (6) sensitivity error; (7) response time error; (8) integration time error; (9) readout electronics error; (10) errors from RF ambient conditions; (11) probe positioner calibration error; (12) probe positioning error with respect to the phantom shell; (13) errors from extrapolation, interpolation, and integration algorithms; (14) test sample output power drift error; (15) SAR variation due to performance tolerance of the test sample; (16) SAR variation due to tolerance of production units; (17) test sample positioning error; (18) device holder or positioner tolerance; (19) phantom production tolerance; (20) target liquid conductivity

tolerance; (21) measured liquid conductivity error; (22) target liquid permittivity tolerance; and (23) measured liquid permittivity error.<sup>63</sup>

Supplement C further concedes<sup>64</sup>:

*“Measurement uncertainties are calculated using the tolerances of the instrumentation used in the measurement, the measurement setup variability, and the technique used to perform the SAR evaluation. The overall uncertainty is calculated in part by identifying uncertainties in the instrumentation chain used in performing each of the procedures in the evaluation.” It is important to reiterate that OEMs self-certify their own results in the face of these same “measurement uncertainties.”*

***D. Though Bulletin 65 from 1997 Discusses Accessories Such as Belt Clips and Holsters, there is no Express Reference to Wireless Device Cases, as Cases and Smart Phones Did Not Exist in 1997.***

Again, however—apart from these already acknowledged variables, and despite the Commission’s existing guidelines to test with accessories and provide corollary caution statements—Bulletin 65 omits any express recommendation to test how form-fitting cases can impact the SAR rating of wireless handsets. This omission is, as previously noted, understandable given that Bulletin 65 was released in 1997 and last updated in 2001, based on a record in a proceeding commenced in 1996—a timeframe that predates smartphones, tablets, and form-fitting cases. Given widespread consumer adoption of cases, however—by as many as 85% of smartphone and tablet users—the absence of cases in testing protocols today is not only material but also may eviscerate the Commission’s fundamental guideline that ***“devices should be tested or evaluated based on normal operating positions or conditions.”***

---

<sup>63</sup> *Id.*, at pages 52-53.

<sup>64</sup> *Id.*, at page 50.

*E. Case Market Statistics Today, and Consumer Adoption of Wireless Devices.*

The market for protective cases is expected to grow at an annual rate of 19.2% per annum between 2012 and 2017, and currently exceeds \$4.5 billion globally.<sup>65</sup> In North America alone, 179 million smartphones and 52 million media tablets shipped in 2012, with totals reaching 262 million smartphones and 73 million tablets by 2017. The protective case market in North America now totals nearly \$1.6 billion and will grow at an annual rate of 14.8% through 2017 when revenues will exceed \$3.1 billion.<sup>66</sup> The so-called “attachment rate” (i.e., that rate at which consumers purchase) for cases is 0.5X at device point of sale<sup>67</sup> and—based upon anecdotal information provided to Pong and published industry research—may exceed a rate of **at least 1.5 per device** over time.

Consumer adoption and use of wireless devices has changed dramatically since the publication of Bulletin 65 in 1997 and Supplement C in 2001. Fifteen years ago, the majority of Americans did not have cell phones. But reliance upon wireless devices has since skyrocketed. In 1996, wireless penetration in the United States was just 16%; in 2001 it was 44.2%; and by 2011 it was 104.6%.<sup>68</sup> Annualized minutes of use in 1996 totaled 51.97 billion; in 2001 it was 456.96 billion; and in 2011 it was 22.96 trillion.<sup>69</sup> Annualized wireless data revenues increased from \$0 in 1996 to \$62.7 billion in 2011.<sup>70</sup> Americans today rely on their devices, using and carrying them in their clothing and against their heads and bodies, for longer periods than ever before—indeed even sleeping

---

<sup>65</sup> Source: ABI Research.

<sup>66</sup> *Id.*

<sup>67</sup> *Id.*

<sup>68</sup> Source: CTIA. See <http://www.ctia.org/advocacy/research/index.cfm/AID/10323>.

<sup>69</sup> *Id.*

<sup>70</sup> *Id.*



with them<sup>71</sup>--such that “body worn configuration” has become not the exception but the norm. It is important to recall in this context that—while “body worn configuration” (and body SAR testing) under Bulletin 65 contemplates the placement of a cell phone at least 15 mm away from the user—modern habits tend towards much closer proximities, as well as longer exposures.<sup>72</sup>

***F. Effects of Cases on Portable Devices: Cases Can Completely Change (and May Increase) Radiation Absorption.***

**Because after-market form-fitting cases contour to devices themselves, these products—that are neither tested nor assumed in the handset equipment authorization process—have become as integral to devices as OEM phone and tablet shells.** As such, a case can detrimentally impact not only consumers’ experiences of wireless network service quality but also their absorption of radiation. ***The resultant “radiation profile” of a given device with a case may bear little resemblance to that of the same device without a case, as tested in the equipment authorization process.*** This altered profile, as well, might dramatically increase SAR<sup>73</sup> or dramatically reduce

---

<sup>71</sup> See <http://www.digitalbuzzblog.com/infographic-how-adults-are-using-mobile-phones> and <http://www.time.com/time/health/article/0,8599,1658166,00.html>.

<sup>72</sup> See Supplement C, at page 41. Supplement C contemplates that, if a belt clip or holster accompanies a portable device, it should be tested in the accessory next to the test phantom. “*Body-worn accessories may not always be supplied or available as options for some devices that are intended to be authorized for body-worn use. A separation distance of 1.5 cm between the back of the device and a flat phantom is recommended for testing body-worn SAR compliance under such circumstances. Other separation distances may be used, but they should not exceed 2.5 cm.*”

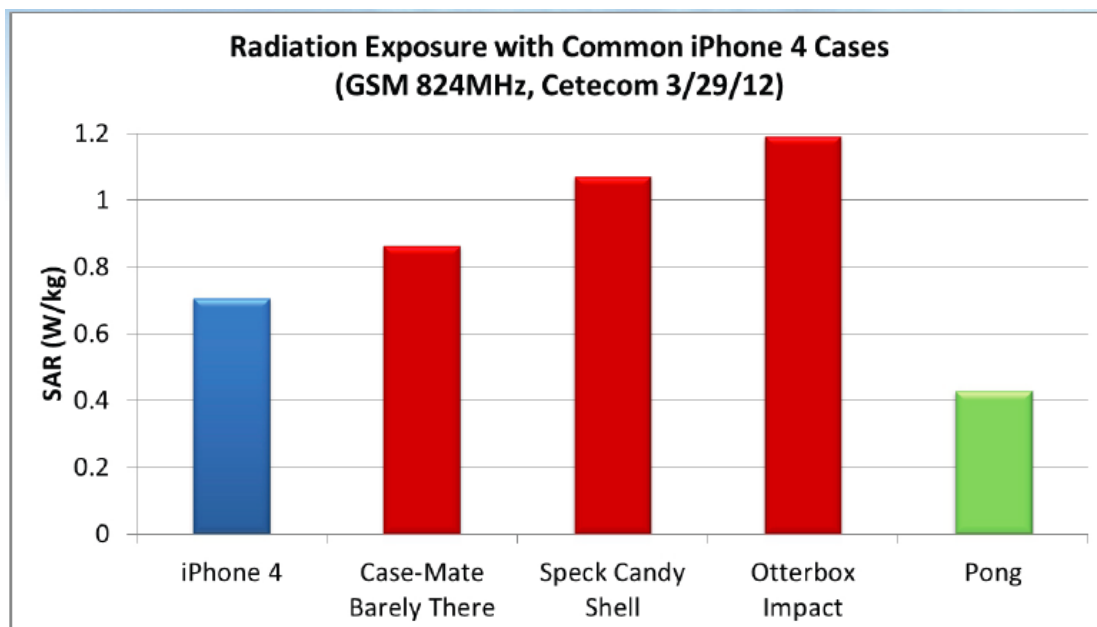
<sup>73</sup> The increased SAR profile in actual use, moreover, might even exceed the “theoretical” assumptions that inform the Commission’s safety standard of 1.6 W/kg. As Supplement C acknowledges, “*Device performance may shift because of dielectric loading.*” Supplement C, at page 13. The efficiency of an antenna depends on the dielectric character of its surrounding medium. Cellular antennas are typically designed to operate surrounded mostly by air. Changing the material surrounding the antenna—for example, with a case—can alter the impedance match and affect the antenna’s efficiency. In some scenarios (dependent on frequency and dielectric properties) efficiency can be improved, so that the antenna radiates more power. The addition of a case to a device, therefore, could change antenna efficiency and increase radiated power, so that the safety limit is violated. In any event, the stated SAR rating of a device for purposes of its equipment authorization would differ from its actual SAR emission with the addition of a form-fitting case. The fact that consumers generally use their devices against their

radiated power. The Commission recognized this unassailable fact at least as early as 2001, as noted above.<sup>74</sup>

***G. Test Data Demonstrate that Cases Can Eviscerate the Entire Equipment Authorization Process.***

In the interest of a fact-based proceeding, the following charts show the impact that several leading brands of cases have on SAR and TRP . We are pleased to share any raw test data with the Commission. **Figure 4** shows the impacts of various cell phone cases (including a Pong case) on the SAR of an iPhone 4, on a sample GSM 824 MHz band tested at CETECOM<sup>75</sup> on March 29, 2012.

**Figure 4. Effects of Cases on SAR of iPhone 4—CETECOM Results**



---

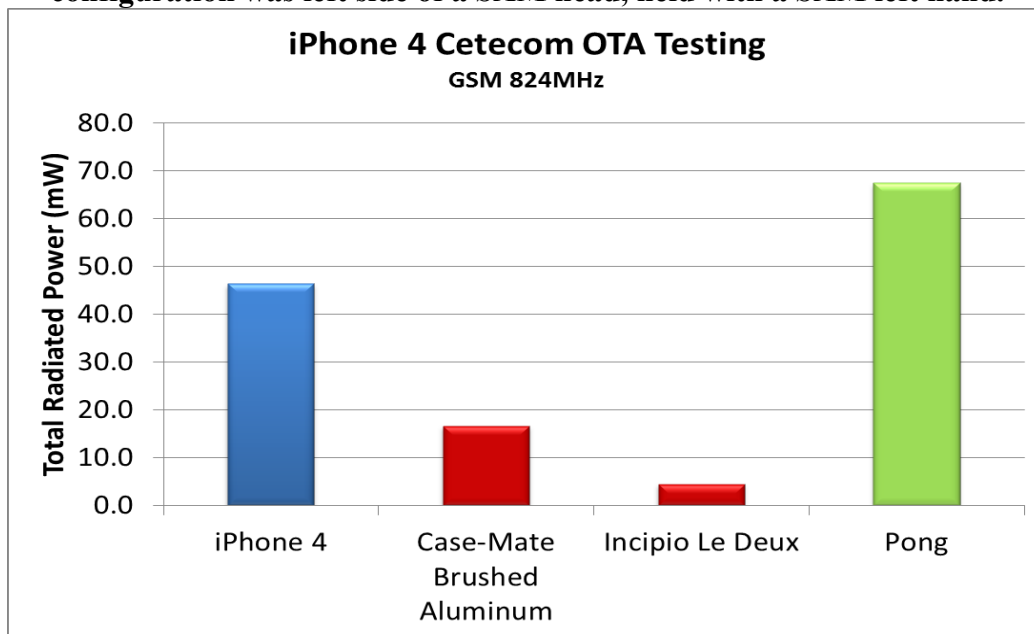
heads and bodies—again, contrary to the assumptions that underlie both the Commission’s safety standard and equipment authorization testing regulations—would exacerbate this state of affairs.

<sup>74</sup> See Section I.A (penultimate paragraph).

<sup>75</sup> The Commission recognizes CETECOM as a Telecommunications Certification Body or “TCB.” See [www.cetecom.com](http://www.cetecom.com). Pong tests its cases in third-party facilities (including CETECOM) certified by the Commission, and calibrates its own extensive equipment to these industry standards.

**Figure 5** compares the Total Radiated Power (“TRP”) of an iPhone 4 measured in an OTA (Over The Air) test in an anechoic chamber at CETECOM.

**Figure 5. Effects of Cases on TRP of iPhone 4—CETECOM Results. Test configuration was left side of a SAM head, held with a SAM left hand.**



As demonstrated by the testing results shown above, cases can materially impact SAR and TRP. Accordingly, we recommend that, at a minimum, testing standards that already apply to belt clips and holsters, should be extended to cases, as well.

***H. Both Metallic and Non-Metallic Cases Can Affect SAR. The Commission Should Eliminate the Antiquated Presumption that Non-Metallic Accessories Cannot Impact SAR, and Revise Its Testing Guidelines and Consumer Notifications Accordingly.***

**1. The Commission’s Guidelines Incorrectly Assume that Accessories Without Metal Parts Cannot Increase SAR.**

Since 1997, the Commission’s guidelines have incorrectly assumed (and so advised consumers as well as manufacturers) that only cases with (and not those without) metal parts can increase SAR. Supplement C says:

*Body-worn operating configurations should be tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in normal use configurations. . . . **For purpose of determining test requirements, accessories may be divided into two categories: those that do not contain metallic components and those that do.***

*When multiple accessories **that do not contain metallic components** are supplied with the device, the device may be tested with only the accessory that dictates the closest spacing to the body. When multiple accessories **that contain metallic components** are supplied with the device, the device must be tested with each accessory that contains a unique metallic component. If multiple accessories **share an identical metallic component** (e.g., the same metallic belt-clip used with different holsters with no other metallic components), only the accessory that dictates the closest spacing to the body must be tested.*

*Body-worn accessories may not always be supplied or available as options for some devices that are intended to be authorized for body-worn use. A separation distance of 1.5 cm between the back of the device and a flat phantom is recommended for testing body-worn SAR compliance under such circumstances. Other separation distances may be used, but they should not exceed 2.5 cm. In these cases, the device may use body-worn accessories that provide a separation distance greater than that tested for the device **provided however that the accessory contains no metallic components.***

*In order for users to be aware of the body-worn operating requirements for meeting RF exposure compliance, operating instructions and caution statements*

*should be included in the manual. The information should allow users to make informed decisions on the type of body-worn accessories and operating configurations that are appropriate for the device. The following are examples of typical statements that provide end-users with the necessary information about body-worn accessories:*

1. *For a product that has the potential to be used in a body worn configuration and has been tested and certified with a specific accessory device(s): “For body worn operation, this phone has been tested and meets the FCC RF exposure guidelines when used with the (manufacturer name) accessories supplied or designated for this product. Use of other accessories may not ensure compliance with FCC RF exposure guidelines.”*

2. *For a product that has the potential to be used in a body worn configuration and has not been certified with a specific accessory device(s): “For body worn operation, this phone has been tested and meets FCC RF exposure guidelines **when used with an accessory that contains no metal** and that positions the handset a minimum of (specified distance) from the body. Use of other accessories may not ensure compliance with FCC RF exposure guidelines.”*

3. *For a product that has the potential to be used in a body worn configuration with future manufacturer designed accessories: “For body worn operation, this phone has been tested and meets the FCC RF exposure guidelines when used with a (manufacturer name) accessory designated for this product or **when used with an accessory that contains no metal** and that positions the*

*handset a minimum of (specified distance) from the body.*”<sup>76</sup>

The assumption that only cases with metal parts can increase SAR (and that OEMs need not test non-metallic accessories) has cascaded into original equipment manufacturers’ instructions to consumers. Apple, for example—in its 156 page, electronic-only manual for the iPhone 5 (which appears at *Settings > General > About > Legal > RF Exposure*)—advises users (at page 147):

*To reduce exposure to RF energy, use a hands-free option, such as the built-in speakerphone, the supplied headphones, or other similar accessories. Carry iPhone at least 10mm away from your body to ensure exposure levels remain at or below the as-tested levels. **Cases with metal parts may change the RF performance of the device, including its compliance with RF exposure guidelines, in a manner that has not been tested or certified.***

Such advisories do not address how cases *without* metal parts might negatively impact SAR, and so tacitly lead consumers to believe (to the extent that consumers would read the manuals) that *non-metallic cases cannot increase RF exposure*.

## **2. Test Results from a Telecommunications Certification Body: Cases Without Metal Parts Can Increase SAR.**

Pong tested an iPhone 4 alone, with various cases, and with a Pong case—*none of which contained metal*—at CETECOM, a telecommunications certification body (“TCB”) certified by the Commission. On a sample frequency of GSM 824 MHz, SAR for the iPhone 4 was 0.705. With various third party, non-metallic aftermarket cases applied to the same device, SAR was consistently higher (except that, with a Pong case,

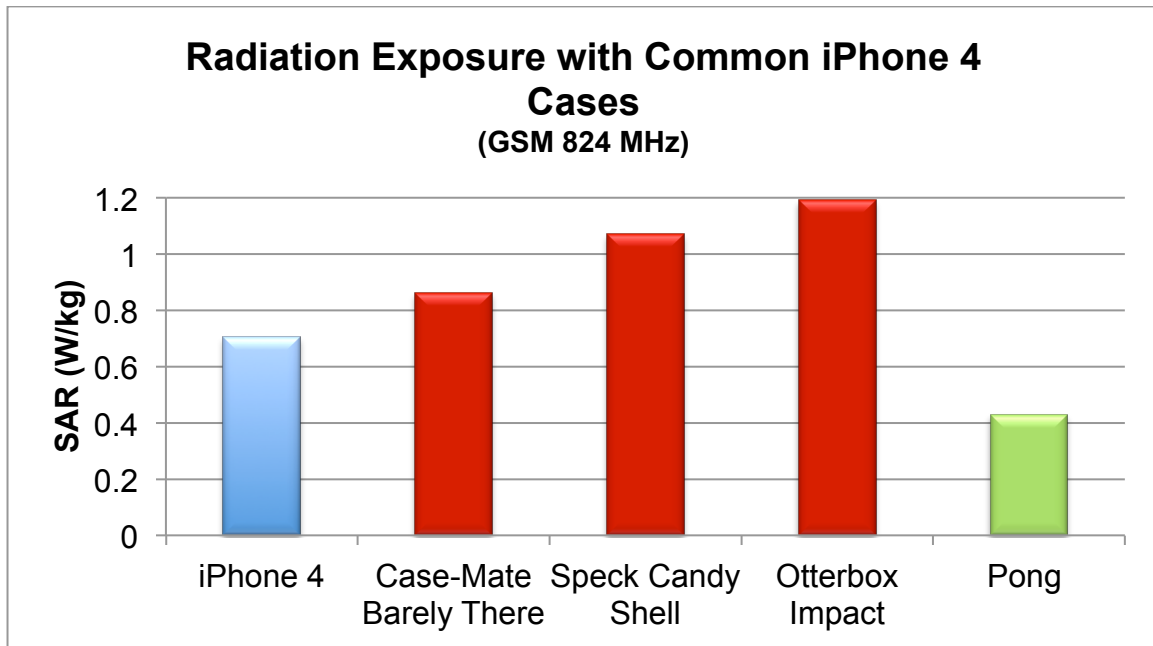
---

<sup>76</sup> Supplement C, at page 41.

SAR was 0.428, a difference of approximately 40% and over 73% below the Commission's limit of 1.6 W/kg). The following tabular material summarizes CETECOM's findings:

Device/GSM 824 MHz	SAR (W/kg)
iPhone 4	0.705
Case-Mate Barely There	0.862
Speck Candy Shell	1.07
Otterbox Impact	1.19
Pong	0.428

**Figure 6. Radiation Exposure with Common iPhone 4 Cases—CETECOM Results on 824 MHz**



The foregoing results, moreover, are tested at separation distances and according to standards extant in Bulletin 65, rather than at “zero” spacing which is how most consumers use wireless devices in body worn configuration. For some wireless devices, SAR—if measured when the device is used directly against the body—might exceed the Commission’s safety standard of 1.6 W/kg. The presence of some cases, including cases *without* metal parts, could exacerbate this effect.

Evidence demonstrates that both metallic and non-metallic cases affect SAR. The Commission should eliminate the presumption that non-metallic accessories do not impact SAR, require testing of devices that would include metallic as well as non-metallic accessories (including cases), and require that consumers be fully informed with respect to these impacts.

**V. CONSUMER INFORMATION SHOULD BE MORE ACCESSIBLE AND INFORMATIVE, INCLUDING AT POINT OF SALE.**

In Section 7, the NOI asks:

*“whether the Commission should consistently require either disclosure of the maximum SAR value or other more reliable exposure data in a standard format – perhaps in manuals, at point-of-sale, or on a website.”<sup>77</sup>*

And in Section 234, the NOI asks:

*“[W]hether the Commission should consistently require either disclosure of the maximum SAR value or other more reliable exposure data in a standard*

---

<sup>77</sup> NOI, Section 7.



*format, perhaps in manuals, at point-of-sale, or on a website.*”<sup>78</sup>

The FCC should update its guidelines so that consumers are provided more easily accessible information about how to reduce exposure to RF energy from wireless devices. For example, a typical consumer remains unaware of the fine print in detailed user manuals, and therefore may not know that—if she holds a portable device close to her body—she may be absorbing higher levels of radiation than the FCC’s safety limit permits. The GAO noted that user manuals typically *“include a statement that, when used on the body, as opposed to against the ear, a minimum distance between the body and the mobile phone should be maintained. These distances ranged from 1.5 to 2.5 centimeters.”*<sup>79</sup> While such “fine print” disclosures in lengthy user manuals may be intended to satisfy some legal obligation, they fail to accomplish the most important objective: to ensure that consumers understand exposure risks, so that they might exercise precautions. The FCC should, therefore, modernize its guidelines better to inform consumers as to how to exercise precautions. These steps could include more prominent advisories, for example, at point of sale, on packaging, and on web sites, that would be easier for consumers to see.

Further, consumers should be provided sufficient information to enable them to choose a portable device that will expose them to the least amount of RF energy. The FCC has noted, *“a single SAR value does not provide sufficient information about the amount of RF exposure under typical usage conditions to reliably compare individual cell phone models.”*<sup>80</sup> We recommend that the FCC create a more reliable exposure

---

<sup>78</sup> NOI, Section 234.

<sup>79</sup> GAO Report at p. 27.

<sup>80</sup> See <http://www.fcc.gov/guides/specific-absorption-rate-sar-cell-phones-what-it-means-you>.

metric than maximum SAR value, and that would be consistently disclosed to the public in manuals, at the point-of-sale, and FCC and manufacturer websites.

## **VI. THE FCC SHOULD ENCOURAGE CONSUMER AWARENESS OF RF ENERGY ISSUES AND PRECAUTIONARY MEASURES, AND SHOULD NOT RELAX EXISTING SAFETY STANDARDS.**

The FCC should do its utmost to encourage consumer awareness of RF energy issues and precautionary measures, and refrain from activities that might unintentionally provide consumers with a false sense of security. The scientific community has not come to any final conclusions on the potential health effects of wireless device use. Recent studies have been unable to rule out adverse health impact of low-level non-ionizing RF energy, and biological effects were noted in various studies,<sup>81</sup> while other studies did not demonstrate any correlation between cell phone use and adverse health effects.<sup>82</sup> The GAO Report noted that FDA and others maintain the conclusion that “*insufficient information was available to conclude mobile phones posed no risk.*”<sup>83</sup>

Given this uncertainty, the GAO’s conclusions that FCC’s flawed testing standards likely underestimate radiation absorption by consumers, and the FCC’s

---

<sup>81</sup> These studies include the 2011 World Health Organization report that classified cell phone radiation as *possibly carcinogenic to humans*; the “Interphone” study that showed an increased risk of a certain type of brain tumor called “glioma” from the regular use of cell phones; a study published in the *Journal of the American Medical Association* that found that just 50 minutes of cell phone use has been proven to alter activity in the brain area closest to the phone; and a 2012 Yale University School of Medicine study conducted in mice, that concluded that exposure to radiation from cell phones during pregnancy affects the brain development of offspring, potentially leading to hyperactivity.

<sup>82</sup> The GAO Report stated: “*Studies we reviewed suggested and experts we interviewed stated that epidemiological research has not demonstrated adverse health effects from RF energy exposure from mobile phone use, but the research is not conclusive because findings from some studies have suggested a possible association with certain types of tumors, including cancerous tumors.*”<sup>82</sup> GAO also noted, “*Overall study findings did not show an increased risk of brain tumors from mobile phone use, but at the highest level of exposure, findings suggested a possible increased risk of glioma.*”<sup>82</sup> GAO Report at p. 8.

<sup>83</sup> *Id.*, at page 6. In spite of this fact, the FCC states on its website: “*Any cell phone at or below these SAR levels (that is, any phone legally sold in the U.S.) is a ‘safe’ phone, as measured by [current testing] standards.*” See <http://www.fcc.gov/encyclopedia/specific-absorption-rate-sar-cellular-telephones>.

acknowledged lack of scientific or medical expertise in the subject matter,<sup>84</sup> the FCC should not affirmatively designate cell phones as either “safe” or “unsafe.” Instead, the FCC should inform consumers that the science is inconclusive, and provide consumers with as much information as possible as to how to best exercise precautions and minimize exposure. Given the uncertainty of the scientific and medical evidence, as well as the extent of the potential public health implications of cell phone use, which statistically exceeds 100% of the United States population, the FCC should also refrain from relaxing the safety standard, until such time as the medical and scientific research concludes that use of wireless devices in the manner that consumers including children normally use such devices, is safe.

It is instructive in this context to note that CTIA, the trade association that represents the wireless industry, has assiduously disavowed any direct claim the cell phones are “safe.” Dane Snowden, Vice President of External and State Affairs of CTIA, for example, has testified:

*I want to be very clear. Industry has not said once, [not] once, that cell phones are safe. The federal government, the various inter-agency working groups, have all said that it's [sic] safe.*<sup>85</sup>

CTIA has instead relied on the FCC’s circuitous characterization that “any cell phone at or below . . . SAR levels [of 1.6 W/kg] is a ‘safe’ phone, as measured by [current testing] standards”—standards that the GAO Report called into serious doubt and that remain at issue in the NOI. Indeed, the Commission itself admits in the NOI:

---

<sup>84</sup> See NOI Section 6.

<sup>85</sup> Testimony of Dane Snowden, Vice President of External and State Affairs CTIA, before City Council of Burlingame, Vermont, September 20, 2010. <http://www.youtube.com/watch?v=s5yGTZq06zQ>.

*Since the Commission is not a health and safety agency, we defer to other organizations and agencies with respect to interpreting the biological research necessary to determine what levels are safe.*<sup>86</sup>

## **VII. CONCLUSION.**

The Commission's equipment authorization process is designed to protect the safety and welfare of consumers. To ensure the integrity and accuracy of the equipment authorization process, we urge the FCC to update its testing guidelines in accordance with the recommendations set forth herein. Among these:

1. Testing methodologies, including SAM specifications, should be modified more closely to simulate the physiological characteristics of children.<sup>87</sup> Available data indicates that the FCC's current testing regime may substantially underestimate real radiation absorption by children.<sup>88</sup>

2. Testing guidelines should be updated to reflect use of devices directly against the body, rather than at least 15mm to 25 mm away. Most consumers hold their devices against their bodies and heads. A space of at least 15 mm dramatically impacts SAR, but that is not how consumers typically use devices. Modern habits tend towards much closer proximities, as well as longer exposures.

3. A substantial majority of wireless device users today employ cases that, unquestionably, dramatically impact SAR.<sup>89</sup> To safeguard the continued integrity of the

---

<sup>86</sup> *Id.*

<sup>87</sup> Filing of Pong Research Corporation in ET 03-137. *See* <http://apps.fcc.gov/ecfs/document/view?id=7022005159> at pp. 4-5.

<sup>88</sup> *Id.*

<sup>89</sup> Pong's letter dated May 31, 2012 to the Commission (filed in the Commission's WT Docket No. 11-186) discusses consequent impacts from form-fitting cases on wireless device reception, battery life, and overall network efficiency—as well as on SAR.

testing program that underlies the equipment authorization process, and properly to promote consumers' safety and welfare, the Commission should—consistent with the purposes of Bulletin 65—update its testing guidelines more accurately to reflect predominant consumer behavior. This update should incorporate testing guidelines that include the presence of a case, which would more accurately determine (among other things) the real absorption of radiation by wireless device users. The Commission should also conclude that both requiring that advisory information be more prominent and detailed and supplying accessories to the consumer could be an effective means to ensure adequate awareness and capability to ensure adherence to the SAR standards under all potential usage conditions.

4. The FCC should update its guidelines so that consumers are provided more easily accessible information about how to reduce exposure to RF energy from wireless devices. The FCC should, therefore, modernize its guidelines better to inform consumers as to how to exercise precautions. These steps could include more prominent advisories, for example, at point of sale, on packaging, and on web sites, that would be easier for consumers to see.

5. The FCC should inform consumers that the science is inconclusive, and provide consumers with as much information as possible as to how to best exercise precautions and minimize exposure, in essence adopting a “precautionary principle.” The FCC should also refrain from relaxing the safety standard, until such time as the medical and scientific research concludes that use of wireless devices in the manner that consumers including children normally use such devices, is safe.

Respectfully submitted,

PONG RESEARCH CORPORATION

A handwritten signature in blue ink, appearing to read 'K. Passarello', is positioned above the printed name and title.

**Kevin L. Passarello**

EVP Business Development and General Counsel  
Pong Research Corporation  
1602 Village Market Blvd, SE Suite 230  
Leesburg, VA 20175

September 1, 2013

## Appendix A

### Biological & Health Effects of Cell Phone Radiation

#### Scientific Literature & References

**Rong Wang, Ph.D.**

Chief Science Officer, Pong Research Corporation. Ph.D., Massachusetts Institute of Technology  
(Nuclear Engineering and Harvard-MIT Health Sciences & Technology), 2005.

#### Cancer

The Interphone Study Group. Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Int J Epidemiol* 2010; 39(3):675-694. Epub 2010 May 17. [PubMed Abstract](#)

The Interphone Study Group. Acoustic neuroma risk in relation to mobile telephone use: Results of the INTERPHONE international case-control study. *Cancer Epidemiol.* 2011 Aug 19. [Epub ahead of print] doi:10.1016/j.canep.2011.05.012. [PubMed Abstract](#)

Cardis E. et al, Risk of brain tumours in relation to estimated RF dose from mobile phones: results from five Interphone countries. *Occup Environ Med.* 2011 September; 68(9): 631–640. [Published Article](#)

WHO. IARC classifies radiofrequency electromagnetic fields as possibly carcinogenic to humans. May 31, 2011. [Full Article](#)

Levis AG, Minicuci N, Ricci P, Gennaro V, Garbisa S. Mobile phones and head tumours. The discrepancies in cause-effect relationships in the epidemiological studies - how do they arise? *Environ Health.* 2011 Jun 17;10:59. [PubMed Abstract](#)

Morgan LL, Kundi, M, & Carlberg M. Re-evaluation of the Interphone Study: Application of a Correction Factor. 2010 June. [Full Article](#)

Carlberg M, Hardell L. On the association between glioma, wireless phones, heredity and ionising radiation. *Pathophysiology* 2012 Aug 28. [PubMed Abstract](#)

Hardell L, Carlberg M and Mild KH. Pooled analysis of case-control studies on malignant brain tumours and the use of mobile and cordless phones including living and deceased subjects. *Int J of Oncology* 38: 1465-1474, 2011. [PubMed Abstract](#)

Khurana VG, Teo C, Kundi M, Hardell L, Carlberg M. Cell phones and brain tumors: a review including the long-term epidemiologic data. *Surg Neurol.* 2009 Sep;72(3):205–215. [PubMed Abstract](#)

Hardell L, Carlberg M and Mild KH. Epidemiological evidence for an association between use of wireless phones and tumor diseases. *Pathophysiology*. 2009 Aug;16(2-3):113-22. Epub 2009 Mar 5. [PubMed Abstract](#)

Hardell L, Carlberg M, Söderqvist F, Mild KH, Morgan LL. Long-term use of cellular phones and brain tumours: increased risk associated with use for > or =10 years. *Occup Environ Med*. 2007 Sep;64(9):626-32. [PubMed Abstract](#)

Hardell L, Mild KH, Carlberg M et al. Tumor risk associated with use of cellular telephones or cordless desktop telephones. *World J Surg Oncol*. 2006; 4:74. [Full Article](#)

Hardell L, Carlberg M, Hansson Mild K: Case-control study of the association between use of cellular and cordless telephones and malignant brain tumours diagnosed 2000–2003. *Environ Res* 2006, 100(2):232-241. [PubMed Abstract](#)

Hardell L, Eriksson M, Carlberg M, Sundström C, Hansson Mild K: Use of cellular or cordless telephones and the risk for non-Hodgkin's lymphoma. *Int Arch Occup Environ Health* 2005, **78**:625-632. [PubMed Abstract](#)

Mild KH, Hardell L et al. Mobile telephones and cancer: Is there really no evidence of an association? (Review) *Int J of Molecular Medicine* 12: 67-72, 2003. [Full Article](#)

Sato Y, Akiba S, Kubo O, Yamaguchi N. A case-case study of mobile phone use and acoustic neuroma risk in Japan. *Bioelectromagnetics* 2011 Feb;32(2):85-93. [PubMed Abstract](#)

Siegal Sadetzki, et al., Cellular Phone Use and Risk of Benign and Malignant Parotid Gland Tumors, A Nationwide Case-Control Study. *American Journal of Epidemiology*, Vol. 167, No. 4; Am J Epidemiol 2008;167:457–467. [PubMed Abstract](#)

Lönn S et al., Mobile phone use and the risk of acoustic neuroma. *Epidemiology*, 2004 Nov;15(6):653-9. [PubMed Abstract](#)

Markovà e et al, Microwaves from Mobile Phones Inhibit 53BP1 Focus Formation in Human Stem Cells More Strongly Than in Differentiated Cells: Possible Mechanistic Link to Cancer Risk. *Environ Health Perspect*. 2010 March; 118(3): 394–399. [Full Article](#)

### **Brain Function and Cognitive Effects**

Volkow N et al. Effects of Cell Phone Radiofrequency Signal Exposure on Brain Glucose Metabolism. *JAMA*, February 23, 2011, Vol 305, No. 8: 808-813. [Full Article](#)

Jing J et al. The influence of microwave radiation from cellular phone on fetal rat brain. *Electromagnetic Biology and Medicine*, 2012 Mar;31(1):57-66. [PubMed Abstract](#)



Chen YB et al. Effect of Electromagnetic Pulses (EMP) on associative learning in mice and a preliminary study of mechanism. *Int J Radiat Biol*. 2011 Dec;87(12):1147-54.

[PubMed Abstract](#)

Khorseva NI, Grigor'ev luG, Gorbunova NV. Psychophysiological indicators for children using mobile phones. Communication 1. Current state of the problem; 2: Results of Four-year Monitoring. *Radiats Biol Radioecol*. 2011 Sep-Oct;51(5):611-623. [PubMed Abstract](#)

Luria R, Eliyahu I, Hareuveny R, et al. Cognitive effects of radiation emitted by cellular phones: the influence of exposure side and time. *Bioelectromagnetics* 2009 Apr 30 (3): 198-204. [PubMed Abstract](#)

Schüz J, Waldemar G, Olsen J, et al. Risks for Central Nervous System Diseases among Mobile Phone Subscribers: A Danish Retrospective Cohort Study. *PLoS One*. 2009;4(2):e4389. [Full Article](#)

Kumar P et al. Acute Effect of Mobile Phone Usage on Cognitive Function. [Full Article](#)

Regel SJ, et al., Pulsed radio frequency radiation affects cognitive performance and the waking electroencephalogram. *Neuroreport* 2007,18:803-807. [PubMed Abstract](#)

Regel SJ. et al., Pulsed radio-frequency electromagnetic fields: dose dependent effects on sleep, the sleep EEG and cognitive performance. *J Sleep Res* 2007, 16:253-258. [Full Article](#)

Ferreri F et al. Mobile phone emission and human brain excitability. *Ann Neurol*. 2006 Aug;60(2):188-96. [Full Article](#)

Lai H, Interaction of microwaves and a temporally incoherent magnetic field on spatial learning in the rat. *Physiology & Behavior* 82 (2004) 785-789. [Full Article](#)

D'Costa H et al. Human brain wave activity during exposure to radiofrequency field emission from mobile phones. *Australas Phys Eng Sci Med*. 2003 Dec;26(4):162-7.

[PubMed Abstract](#)

Edelstyn, N., Oldershaw, A. The acute effects of exposure to the electromagnetic field emitted by mobile phones on human attention. *Neuroreport* 2002 Jan 21;13(1):119-21.

[PubMed Abstract](#)

Huber R, et al. Electromagnetic fields, such as those from mobile phones, alter regional blood flow and sleep and waking EEG. *Journal of sleep research*. 2002;11:289-295.

[PubMed Abstract](#)

Vanessa K et al. Neuropsychological sequelae of digital mobile phone exposure in humans. *Neuropsychologia*. 2006;44(10):1843-1848. [Full Article](#)

Maier R, Greter SE, Maier N. Effects of pulsed electromagnetic fields on cognitive processes - a pilot study on pulsed field interference with cognitive regeneration. *Acta Neurol Scand.* 2004 Jul;110(1):46-52. [PubMed Abstract](#)

Edelstyn N and Oldershaw A. The acute effects of exposure to the electromagnetic field emitted by mobile phones on human attention. *Cognitive Neuroscience and Neuropsychology.* 2002;13:119-121. [PubMed Abstract](#)

Koivisto M et al. Effect of 902 MHz electromagnetic field emitted by cellular telephones on response times in humans. *Neuroreport.* 2000;11:413-415. [PubMed Abstract](#)

Takashima S., Onaral, B., and Schwan, H.P. Effects of modulated RF energy on the EEG of mammalian brain. *Radiat. Environ. Biophys.* 1979; 16(1): 15–27. [PubMed Abstract](#)

Baranski S. Histological and histochemical effects of microwave irradiation on the central nervous system of rabbits and guinea pigs. *Am. J. Phys. Med.* 1972;51: 182–190. [PubMed Abstract](#)

### **Behavioral Effects**

Divan HA, Kheifets L, Obel C, Olsen J. Cell phone use and behavioural problems in young children. *J Epidemiol Community Health.* 2012 Jun;66(6):524-9. [PubMed Abstract](#)

Divan HA, Kheifets L, Obel C, Olsen J. Olsen. Prenatal and Postnatal Exposure to Cell Phone Use and Behavioral Problems in Children. *Epidemiology.* 2008 July 19(4):523-529. [PubMed Abstract](#)

Aldad TS, Gan G, Gao XB & Taylor HS. Fetal Radiofrequency Radiation Exposure From 800-1900 Mhz-Rated Cellular Telephones Affects Neurodevelopment and Behavior in Mice. *Scientific Reports.* 2012 March; 2 : 312. [Full Article](#)

D’Andrea, J.A. Microwave radiation absorption: behavioral effects. *Health Phys.* 1991 Jul;61(1):29-40. [PubMed Abstract](#)

DeWitt JR, D’Andrea JA, Emmerson RY, Gandhi OP. Behavioral effects of chronic exposure to 0.5 mW/cm<sup>2</sup> of 2,450-MHz microwaves. *Bioelectromagnetics.* 1987;8(2):149-57. [PubMed Abstract](#)

D’Andrea, J.A., DeWitt, J.R., Gandhi, O.P., Stensaas, S., Lords, J.L., and Nielson, H.C. 1986b. Behavioral and physiological effects of chronic 2450 MHz microwave irradiation of the rat at 0.5 mW/cm<sup>2</sup>. *Bioelectromagnetics.* 1986;7(1): 45–56. [PubMed Abstract](#)

### **Reproduction and Fertility Effects**

- La Vignera S et al. Effects of the exposure to mobile phones on male reproduction: a review of the literature. *J Andrology* 2012 May-Jun;33(3):350-6. [PubMed Abstract](#)
- Falzone N, et al. The effect of pulsed 900-MHz GSM mobile phone radiation on the acrosome reaction, head morphometry and zona binding of human spermatozoa. *Int J Androl*. 2011 Feb;34(1):20-6. [PubMed Abstract](#)
- Falzone N, et al. In vitro effect of pulsed 900 MHz GSM radiation on mitochondrial membrane potential and motility of human spermatozoa. *Bioelectromagnetics*. 2008 May;29(4):268-76. [PubMed Abstract](#)
- Agarwal A et al. Effect of cell phone usage on semen analysis in men attending infertility clinic: an observational study. *Fertil Steril*. 2008 Jan;89(1):124-8. [PubMed Abstract](#)
- Argawal A, Desai NR, Makker K et al. Effects of radiofrequency electromagnetic waves (RF-EMW) from cellular phones on human ejaculated semen: an in vitro pilot study. *Fertil Steril*. 2009 Oct: 92(4). [Full Article](#).
- De Iuliis et al. Mobile Phone Radiation Induces Reactive Oxygen Species Production and DNA Damage in Human Spermatozoa In Vitro. *PLoS One* 2009 Jul 31;4(7):e6446 : e6446. [Full Article](#).
- Wdowiak A et al. Evaluation of the effect of using mobile phones on male fertility. *Ann Agric Environ Med* 2007 14:169-172. [Full Article](#).
- Derias EM, Stefanis P, Drakeley A, Gazvani R, Lewis-Jones DI. Growing concern over the safety of using mobile phones and male fertility. *Arch Androl*. 2006 Jan-Feb;52(1):9-14. [PubMed Abstract](#)
- Erogul O et al. Effects of Electromagnetic Radiation from a Cellular Phone on Human Sperm Motility: An In Vitro Study. *Archives of Medical Research* 2006 Oct; 37(7):840-3. [Full Article](#).
- Aitken RJ, et al. Impact of radio frequency electromagnetic radiation on DNA integrity in the male germline. *Int J Androl* 2005 June; 28: 171–179. [PubMed Abstract](#)
- Fejes I, et al. Is there a relationship between cell phone use and semen quality? *Arch Androl* 51: 385–393 (2005). [PubMed Abstract](#)
- Desai NR, Kesari KK, Agarwal A. Pathophysiology of cell phone radiation: oxidative stress and carcinogenesis with focus on male reproductive system. *Reprod Biol Endocrinol*. 2009 Oct 22;7:114. [Full Article](#)
- Makker K, Varghese A, Desai NR, Mouradi R, Agarwal A. Cell phones: modern man's nemesis? *Reprod Biomed Online*. 2009 Jan;18(1):148-57. [PubMed Abstract](#)

Magras IN, Xenos TD. RF radiation-induced changes in the prenatal development of mice. *Bioelectromagnetics*. 1997; 18:455-461. [Full Article](#)

### **Cellular and Genetic Effects**

Cam ST, Seyhan N. Single-strand DNA breaks in human hair root cells exposed to mobile phone radiation. *Int J Radiat Biol*. 2012 May;88(5):420-4. [PubMed Abstract](#)

Liu YX et al, Exposure to 1950-MHz TD-SCDMA Electromagnetic Fields Affects the Apoptosis of Astrocytes via Caspase-3-Dependent Pathway. 2012 Aug. PLoS ONE 7(8): e42332. doi:10.1371/journal.pone.0042332. [Full Article](#)

Esmekaya MA et al. Mutagenic and morphologic impacts of 1.8 GHz radiofrequency radiation on human peripheral blood lymphocytes (hPBLs) and possible protective role of pre-treatment with Ginkgo biloba (Egb 761). *Sci Total Environ*. 2011 Dec 1;410-411:59-64. [PubMed Abstract](#)

Gerner C et al. Increased protein synthesis by cells exposed to a 1,800-MHz radio-frequency mobile phone electromagnetic field, detected by proteome profiling. *Int Arch Occup Environ Health*. 2010 August; 83(6): 691–702. [Full Article](#)

Phillip JL, Singh NP, Lai H. Electromagnetic fields and DNA damage. *Pathophysiology*. 2009 Aug; 16(2-3):79–88. [Full Article](#)

Schwarz C et al, Radiofrequency electromagnetic fields (UMTS, 1,950 MHz) induce genotoxic effects in vitro in human fibroblasts but not in lymphocytes. *Int Arch Occup Environ Health*. 2008 May;81(6):755-67. [PubMed Abstract](#)

Stronati L et al, 935 MHz cellular phone radiation. An in vitro study of genotoxicity in human lymphocytes. *Int J Radiat Biol*. 2006 May;82(5):339-46. [PubMed Abstract](#)

Panagopoulos DJ et al. Cell death induced by GSM 900-MHz and DCS 1800-MHz mobile telephony radiation. *Mutation Research* (2006). [Full Article](#)

Diem E, Schwarz C, Adlkofer F, Jahn O, Rudiger H. Non-thermal DNA breakage by mobile-phone radiation (1800MHz) in human fibroblasts and in transformed GFSH-R-17 granulosa cells in vitro. *Mutation Res*. 2005; 583: 178-183. [PubMed Abstract](#)

Zmyślony, M. *et al*. Acute exposure to 930 MHz CW electromagnetic radiation in vitro affects reactive oxygen species level in rat lymphocytes treated by iron ions. *Bioelectromagnetics*. 25, 324–8 (2004). [PubMed Abstract](#)

Lai H, Singh NP. Single- and double-strand DNA breaks in rat brain cells after acute exposure to radiofrequency electromagnetic radiation. *Int J Radiat Biol*. 1996 Apr;69(4):513-21. [PubMed Abstract](#)

## Electromagnetic Hypersensitivity

Johansson A et al. Symptoms, personality traits, and stress in people with mobile phone-related symptoms and electromagnetic hypersensitivity. *J Psychosom Res.* 2010 Jan;68(1):37-45. [PubMed Abstract](#)

Hallberg O, Oberfeld G. Letter to the Editor: Will we all become electrosensitive? *Electromagn Biol Med* 2006; 25: 189-91. [Full Article](#)

Hillert L, Berglind N, Arnetz BB, et al. Prevalence of self-reported hypersensitivity to electric or magnetic fields in a population-based questionnaire survey. *Scand J Work Environ Health* 2002;28(1): 33-41. [PubMed Abstract](#)

Johansson O. Electrohypersensitivity: State-of-the-art of a functional impairment. *Electromagn Biol Med* 2006; 25: 245-58. [Full Article](#)

Schooneveld H, Kuiper J. Electrohypersensitivity (EHS) in the Netherlands. A questionnaire survey. 2nd graphical edition. Stichting EHS (Dutch EHS Foundation), 2008, 23. [Full Article](#)

Havas M. Dirty electricity elevates blood sugar among electrically sensitive diabetics and may explain brittle diabetes. *Electromagn Biol Med* 2008; 27(2): 135-46. [PubMed Abstract](#)

Rubin GJ, Das Munshi J, Wessely S. Electromagnetic hypersensitivity: a systematic review of provocation studies. *Psychosom Med* 2005; 67: 224-32. [PubMed Abstract](#)

Seitz H et al. Electromagnetic hypersensitivity (EHS) and subjective health complaints associated with electromagnetic fields of mobile phone communication--a literature review published between 2000 and 2004. *Sci Total Environ.* 2005 Oct 15;349(1-3):45-55. [PubMed Abstract](#)

Granlund R, Lind J. Black on White: voices and witnesses about electro-hypersensitivity, the Swedish Experience. 2nd Internet Edition Oct 3, 2004. [Full Article](#)

Mild KH, Repacholi M, van Deventer E. Electromagnetic Hypersensitivity. Proceedings International Workshop on EMF Hypersensitivity Prague, Czech Republic October 25-27, 2004, 196. [Full Article](#)

Levallois P. Hypersensitivity of human subjects to environmental electric and magnetic field exposure: a review of the literature. *Environ Health Perspect* 2002; 110 (suppl 4): 613-8. [PubMed Abstract](#)

Haumann T, Sierck P. Nonstop pulsed 2.4 GHz radiation inside US homes. *2nd International Workshop on Biological Effects of Electromagnetic Fields*, 7-11 Oct. 2002. [Full Article](#)

Rea WJ, Pan Y, Fenyves EJ, *et al.* Electromagnetic field sensitivity. *J Bioelectr* 1991; 10: 241-56. [Full Article](#)

### **Other Effects**

Saravi FD, Asymmetries in hip mineralization in mobile cellular phone users. *The Journal of Craniofacial Surgery* 2011 Mar;22(2):706-10. [PubMed Abstract](#)

Yu Y, Yao K. Non-thermal cellular effects of lowpower microwave radiation on the lens and lens epithelial cells. *J Int Med Res.* 2010 May-Jun;38(3):729-36. [Full Article](#)

Atay T *et al.* Effect of electromagnetic field induced by radio frequency waves at 900 to 1800 MHz on bone mineral density of iliac bone wings. *J Craniofac Surg.* 2009 Sep;20(5):1556-60. [PubMed Abstract](#)

Andrzejak R *et al.* The influence of the call with a mobile phone on heart rate variability parameters in healthy volunteers. *Industrial Health* 2008 Aug;46(4):409-17. [PubMed Abstract](#)

Bormusov E *et al.* Non-thermal electromagnetic radiation damage to lens epithelium. *Open Ophthalmol J.* 2008 May 21;2:102-6. [Full Article](#)

Li BF, Guo GZ, Ren DQ, *et al.* Electromagnetic pulses induce fluctuations in blood pressure in rats. *Int J Radiat Biol* 2007; 83: 421-9. [PubMed Abstract](#)

Mariea T and Carlo G, Wireless radiation in the etiology and treatment of autism: clinical observations and mechanisms. *J. Aust. Coll. Nutr. & Env. Med.* Vol. 26 No.2 (August 2007) pages 3-7. [Full Article](#)

Burch JB *et al.* Melatonin metabolite excretion among cellular telephone users. *Int J Radiat Biol.* 2002 Nov;78(11):1029-36. [PubMed Abstract](#)

Hillert L, Akerstedt T, Lowden A, Wiholm C, Kuster N, *et al.* (2008) The effects of 884 MHz GSM wireless communication signals on headache and other symptoms: an experimental provocation study. *Bioelectromagnetics* 2008 Apr;29(3):185–196. [PubMed Abstract](#)

Arnetz BB *et al.* The Effects of 884 MHz GSM Wireless Communication Signals on Self-reported Symptom and Sleep (EEG)- An Experimental Provocation Study *PIERS Online* 3(7):1148-1150 2007. [Full Article](#)

## New Warnings on Wireless Radiation from BioInitiative 2012 Report

Five years after the initial BioInitiative 2007 Report, the BioInitiative Working Group issued an updated 2012 Report to provide a strengthened rationale for biologically-based exposure standards for low-intensity electromagnetic radiation. [Full Report](#). Prepared by 29 world-recognized experts in science and public health policy from 10 countries, the BioInitiative 2012 Report reviewed over 1800 new scientific studies and shows reinforced evidence of risk from chronic exposure to low-intensity electromagnetic fields (EMF) and to wireless technologies (radiofrequency radiation (RFR) including microwave radiation). The Report concludes that existing public safety limits are inadequate to protect public health, and that new, biologically-based public safety limits are needed.

The 2012 Report presents the following new evidence and key information:

- About 1800 new scientific studies have been published in the last 5 years (2007-2012) reporting biological/health effects at exposure levels ten to hundreds or thousands of times lower than safety limits in most countries of the world. The levels of concern have dropped lower in 2012 by 10s to 100s of times.
- New studies largely reinforce the potential risks to health. A snapshot of the reported evidence shows a broad range of biological and possible adverse health effects from chronic exposures, including:
  - **Genotoxic effects**, including DNA damage, abnormal gene transcription, chromatin condensation, micronucleation, and impaired repair of DNA damage in human stem cells.
  - **Molecular and cellular effects**, including changes in cell membrane function, cell communication and cell metabolism, cell death, increased free radical production, activation of proto-oncogenes, and production of stress proteins.
  - **Brain and nervous system effects**, including pathological leakage of the blood–brain barrier, changes in brain glucose metabolism, altered brainwave activity (altered EEG), neurotoxicity, memory loss, headaches, fatigue, sleep disorders, retarded learning, slower motor function and other performance impairment in children.
  - **Cancers** in humans including increased risk of brain tumors and acoustic neuromas.
  - **Immune function effects** including increased allergic and inflammatory responses
  - **Reproductive effects**, including serious impacts on human and animal sperm quality and function, effects on offspring behavior and effects on brain and cranial bone development in the offspring of animals that are exposed to cell phone radiation during pregnancy, altered fetal brain development and ADHD-like behavior in the offspring of exposed pregnant mice.



➤ **Effects on Autism (Autism Spectrum Disorders).**

- There is inadequate warning and notice to the public about possible risks from wireless technologies in the marketplace. There is no informed consent for consumers (warning labels on cell phones, for example, have been defeated by telecom industry lobby groups). It is still difficult or impossible for a consumer to get reliable information on levels of exposure from wireless devices. There is little indication that cell phone users (whose numbers have risen from roughly 2 billion in 2006 to 6 billion users globally in 2012) are aware of the risks.
- The issues around fetus and childhood exposure are of particular importance. There is good evidence to suggest that many toxic exposures to the fetus and very young child have especially detrimental consequences depending on when they occur during critical phases of growth and development (time windows of critical development), where such exposures may lay the seeds of health harm that develops even decades later. There is overwhelming evidence that children are more vulnerable than adults to many different exposures, including RFR, and that the diseases of greatest concern are cancer and effects on neurodevelopment. Existing FCC (Federal Communications Commission) and ICNIRP (International Commission on Non-Ionizing Radiation Protection) public safety limits seem to be insufficiently protective of public health, in particular for the young (embryo, fetus, neonate and very young child).
- In 2011 the World Health Organization International Agency on Cancer Research (IARC) classified radiofrequency radiation (RFR) as a Group 2B Possible Human Carcinogen, joining the IARC classification of ELF-EMF that occurred in 2001. The evidence for carcinogenicity for RFR was primarily from cell phone/brain tumor studies. While a definitive link between cell phone radiation and brain cancer has not been established, these studies and others clearly demonstrate the need for further research into this area and highlight the importance of reassessing the current SAR to determine if it is protective of human health.
- The standard for taking action should be precautionary; action should not be deferred while waiting for final proof or causal evidence to be established that EMF is harmful to health and well-being. The Precautionary Principle has been developed to help justify public policy action on the protection of health where there are plausible, serious and irreversible hazards from current and future exposures and where there are many uncertainties and much scientific ignorance. EMF is characterized by such circumstances.

The critiques of the Report include its selective, rather than comprehensive review of the literature in various research topics and therefore a lack of balance in general.